

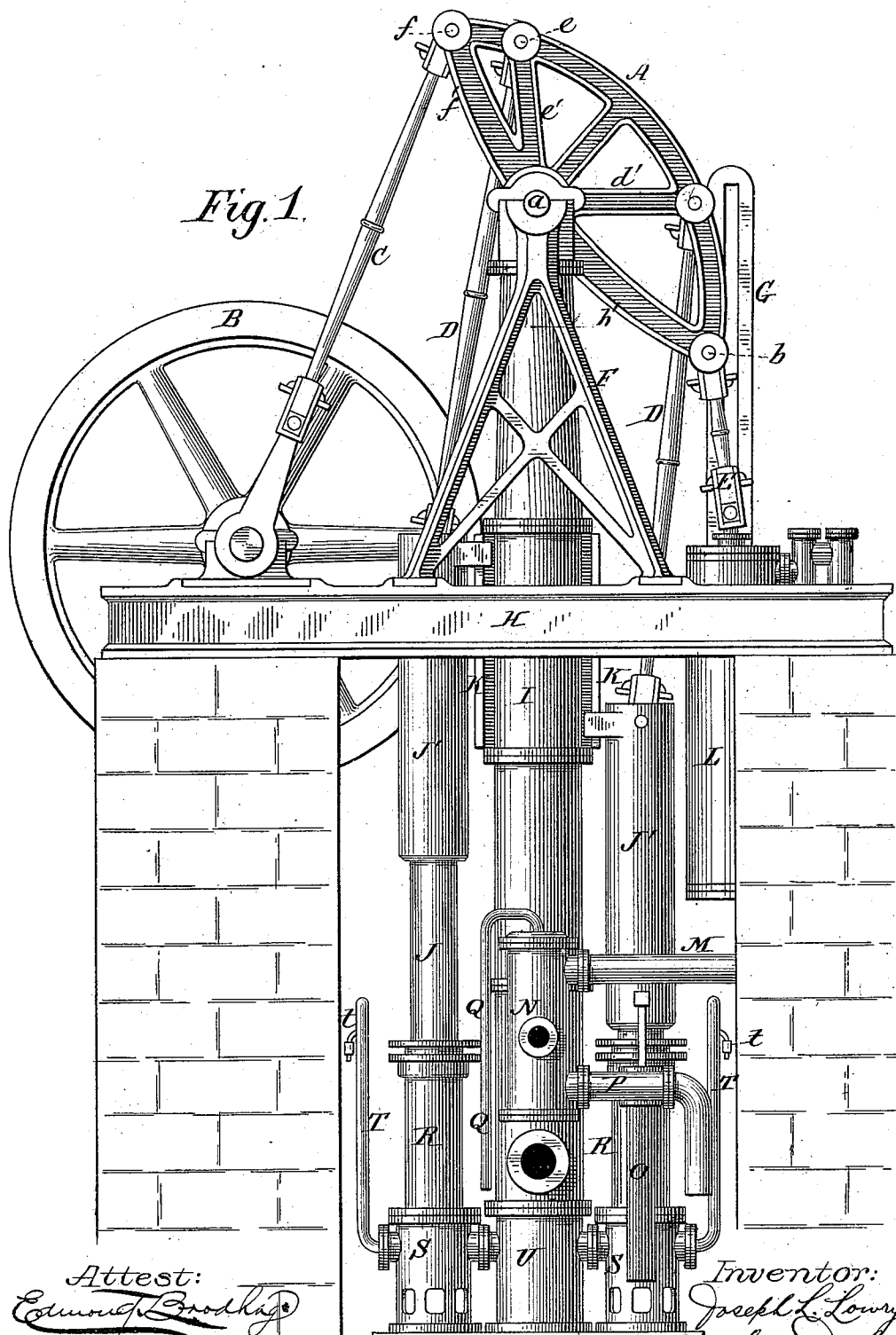
(No Model.)

3 Sheets—Sheet 1.

J. L. LOWRY.
STEAM PUMPING ENGINE.

No. 298,596.

Patented May 13, 1884.



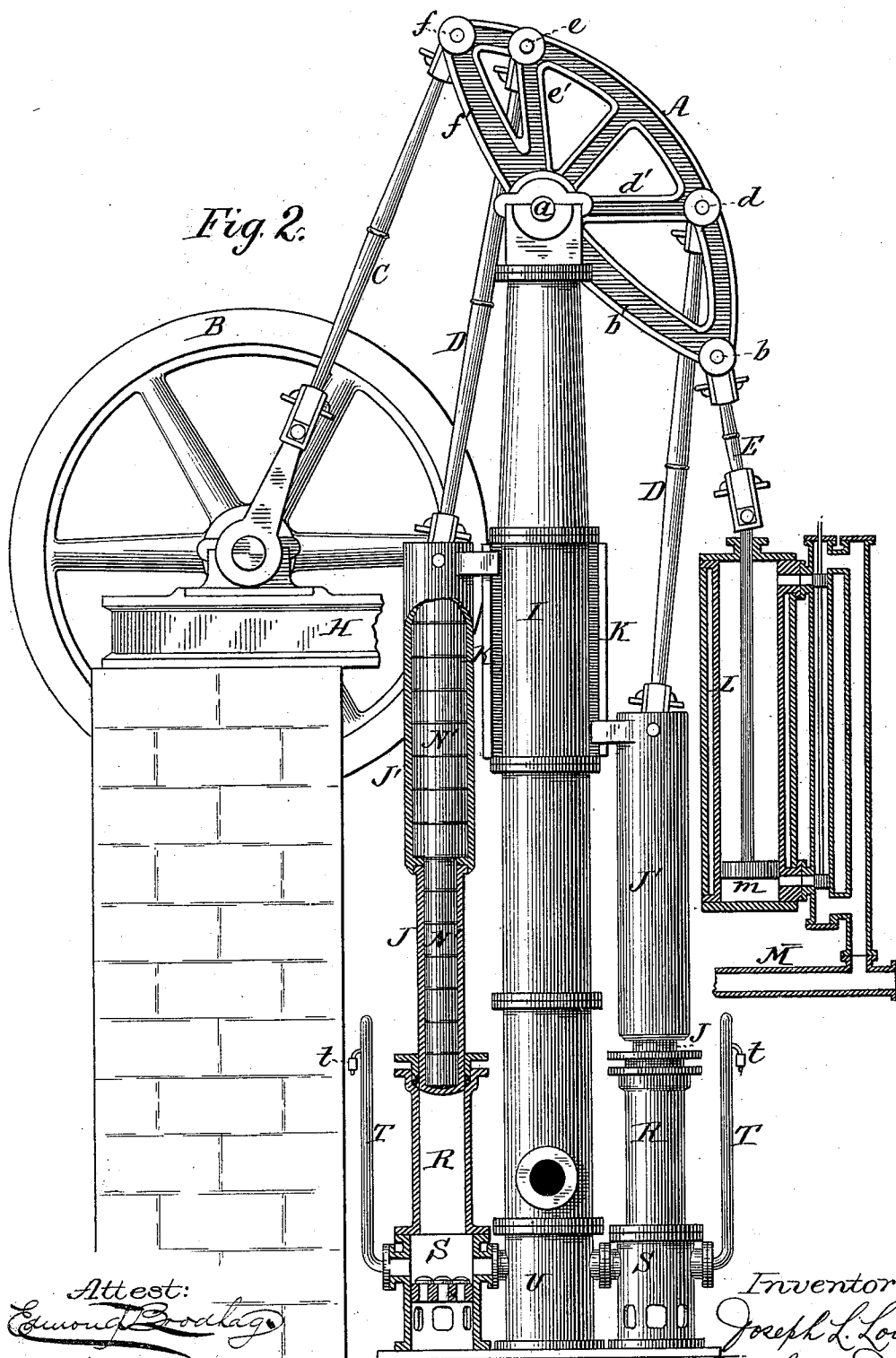
(No Model.)

3 Sheets—Sheet 2.

J. L. LOWRY.
STEAM PUMPING ENGINE.

No. 298,596.

Patented May 13, 1884.



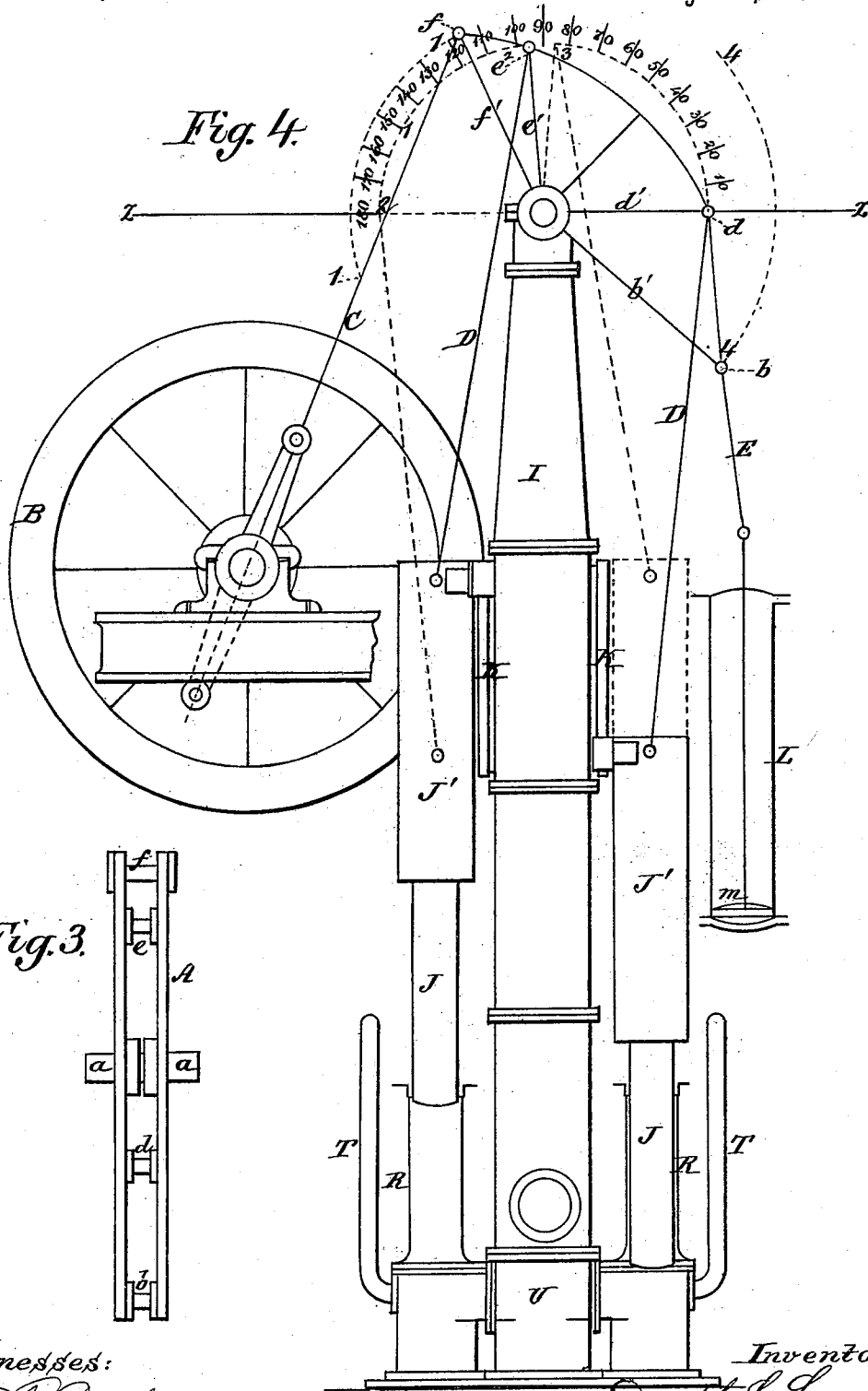
Attest:
Edward Brodtag
Lowell Bartle

Inventor:
Joseph L. Lowry
by Johnson & Johnson
his Attys

J. L. LOWRY.
STEAM PUMPING ENGINE.

No. 298,596.

Patented May 13, 1884.



Witnesses:

J. C. Brecht
Fred D. Church.

Inventor
Joseph L. Lowry
by Johnson & Johnson
Attys.

UNITED STATES PATENT OFFICE.

JOSEPH L. LOWRY, OF PITTSBURG, PENNSYLVANIA.

STEAM PUMPING-ENGINE.

SPECIFICATION forming part of Letters Patent No. 298,596, dated May 13, 1884.

Application filed January 9, 1884. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH L. LOWRY, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented new and useful Improvements in Steam Pumping-Engines, of which the following is a specification.

My invention relates to improvements in steam pumping-engines, in which two vertically-acting plungers are combined with an engine in such manner that, as the steam gradually decreases in pressure by expansion, the labor or load on the piston will be correspondingly reduced, so that the elastic force or expansive power of the steam may be applied to operate the engine before it is exhausted, as in a patent granted to me March 10, 1868, No. 75,284.

My present improvement is directed to a construction whereby the load on the piston in raising the plunger shall be mechanically reduced in proportion as the force of the steam is reduced by expansion within the cylinder, and thereby utilize and apply the whole expansive force of the steam in the cylinder, and to relieve the strain when reversing the plungers at the end of the stroke. These objects I effect by greatly increasing the weight of the plungers in excess of that required to raise a column of water to a predetermined level, and in the manner of connecting and operating them, as will be hereinafter more fully described, and the improvement made the subject of specific claims.

Referring to the accompanying drawings, Figure 1 represents a side elevation of a vertical pumping-engine, one of the cross-head guides G of the engine being removed; Fig. 2, a vertical sectional side elevation of the same, showing the counter-weights in the left-hand plunger and plunger-head; Fig. 3, a top view of the beam; and Fig. 4, an elevation of the pump, showing in diagram the arcs through which the beam travels, to illustrate the changing of the angles of the beam-arms.

The steam pumping-engine is constructed with a vertical steam-cylinder, L, condenser N, air-chamber I, vacuum-pump O, two single-acting vertical plungers, J, working in the pump-cylinders R R, and the discharge-chamber U, similar to those now in use, as in my

said patent. Referring to this patent, with reference to the beam, it is deemed best to state here the operation of the pump under the quadrant form of the beam therein shown, in order that the operation and advantages of the beam of elliptic form, as in my present improvement, may be more fully explained. The beam of quadrant form in said patent is made with three arms of equal length, the two pump-arms standing at nearly right angles to each other, the middle arm being made to connect the piston of a horizontal steam-cylinder. Under this construction, the engine having been set in operation, the piston, at the beginning of the stroke, travels nearly one-fourth slower than the plunger, or as ten of the piston to thirteen of the plunger. At the middle of the stroke the piston travels nearly one-third faster than the plunger, or as seventeen of the piston to twelve of the plunger. At the end of the stroke the piston has increased to a speed of three times that of the plunger, or as eleven of the piston to four of the plunger. The difference in the operation of the engine with my present improvement will be stated in connection with the beam of the elliptic form.

The working-beam A, to which the steam piston m, and plungers J J are connected, is constructed in such manner that the beam-pin b, to which the piston-rod of the vertical engine is connected, travels, in making the stroke, an equal distance above and below the center of the beam-shaft, moving with uniform speed at each end of the stroke. The beam-pins d e, to which the plunger-rods D D are connected, however, should not descend below the center of the beam-shaft. On the upstroke the beam-pins d e rise from a horizontal position with the beam-shaft to nearly a vertical line above the shaft. In this movement the pins travel through nearly a quarter of a circle, and draw the plunger connecting-rod three-fourths nearer to the fulcrum or beam-shaft than at the beginning of the stroke, consequently reducing the speed of the plunger at the end of the stroke to one-fifth of what it moved at the beginning. At the same time, by the movement described, three-fourths of the weight of the plunger is removed from the steam-piston to the beam-shaft, requiring only twenty per cent. of the force of the steam on the piston to

raise the plunger at the slower speed. The steam-piston, in making the stroke, travels fourteen feet, while the plunger travels but eight feet. At the beginning of the stroke both the ascending plunger and the steam-piston travel at nearly uniform speed, but as the plunger gradually decreases its speed until at the end of the stroke the steam-piston is traveling five times faster than the plunger rises. From this it will be seen that only seventy-five per cent. of the steam admitted into the steam-cylinder has thus far been shown to have been utilized.

To utilize and apply the unexpended force of the steam in the cylinder is the object of increasing the weight of the plungers some twenty to thirty per cent. heavier than is required to force or counterbalance the weight of the column of water proposed to be raised. For this purpose the plungers *J* are made hollow, and the plunger-heads *J'* are also made hollow, and of greater diameter, to receive weights *N'*. (Shown in the sectional view in Fig. 2.) The plungers are loaded twenty-five per cent. heavier than is required to force the column of water to a predetermined level. When the engine is in operation, the gravity of the twenty-five per cent. of weight, before stated, is utilized, the weight being transmitted by the beam to the power-cylinder to assist in raising the plunger ascending. As the ascending plunger rises and the descending plunger falls, the angles of the beam-arms operating them are changed. The arm operating the ascending plunger rises from a horizontal line (see Fig. 4) at the commencement of the stroke to an elevation or angle of eighty-four degrees at the end of the stroke. This change of the angle of the beam-arm on the ascent of the plunger acts in a similar manner as if the beam-arm is gradually shortened from eight feet at the beginning to a little over two feet at the end of the stroke. On the contrary, the changing of the angle of the arm which operates the descending plunger during the stroke from an elevation or angle of ninety-six degrees to an angle of one hundred and eighty degrees acts on the plunger as if the arm of the beam had been lengthened from two feet at the beginning of the descent to eight feet long at the end of the stroke. The beam-pin operating the ascending plunger rises from a horizontal line at the beginning of the stroke, and describes an arc of eighty-four degrees to the end of the stroke. On the other hand, the beam-pin operating the descending plunger in making the stroke describes an arc of eighty-four degrees, descending from ninety-six to one hundred and eighty degrees. This peculiar movement of the beam results not only in the gradual reducing of the speed of the plunger as it rises, but also reduces the leverage of the plunger on the beam, and as a consequence relieves the load on the steam-piston at the same time. On the other hand, the gradual increased leverage on the beam of the twenty-five per cent. weight

of the plunger not utilized in forcing the water is increased four times at the end of the stroke, counterbalancing the weight of the ascending plunger, and also relieving the steam-piston, as it approaches the end of the stroke, of the load or weight of the ascending plunger.

In further explanation of the object of increasing the weight of the plungers, I may say that it is not for the purpose of overcoming the hydrostatic weight of the column of water in the pumping-main, but for the purpose of adding twenty-five per cent. greater load on the piston or resistance to its movement at the commencement of the stroke when the steam is at its greatest pressure, and to reduce the load on the piston twenty-five per cent. when the steam in the cylinder is being reduced by expansion, thereby permitting the steam to be worked to a much lower pressure than would be possible if the plungers were only the weight of the column of water in the pumping-main.

Referring to the construction and operation of the elliptic beam *A*, I prefer to make it of two sections, and join them together by the wrists and the beam-shaft, as shown in Fig. 3, in which the beam journals or bearings *a a* project outside and the wrists between the sections. The beam is formed the shape of an acute ellipse, with four arms differing in length and standing at different angles. The arm *b'*, to which the steam-piston and link *B* are connected, is eleven feet long from center of the beam-shaft to center of the wrist-pin *b*, and stands at an angle of nine degrees with a line, *z z*, drawn through the center of the beam-journals *a a*. The pump-arm *d'* is eight feet long from center of beam to center of pin *d*, and stands at an angle of fifty degrees with the line *z z*. The pump-arm *e'* is eight feet long from center of beam to center of pin *e*, and stands at an angle of one hundred and forty-five degrees. The crank-arm *f'* is nine feet long from center of beam to center of pin *f*, and stands at an angle of one hundred and seventy-one degrees with the line *z z*.

In the operation of the engine, at the commencement of the stroke, the steam-piston travels one-twelfth faster than the plunger. At the middle of the stroke the piston travels nearly double the speed of the plunger, or as eleven to six, while at the end of the stroke the steam-piston has increased its speed to nearly five times that of the plunger. In my present engine, with the vertical steam-cylinder and elliptic beam, the piston increases its speed as compared with that of the plunger from one-twelfth faster at the beginning to five times faster at the end of the stroke, while in the engine with the horizontal cylinder and quadrant-beam, the piston at the beginning of the stroke travels one-fourth slower than the plunger and three times faster than the plunger at the end of the stroke. The increased length in the arms of the elliptic beam over

that of the quadrant gives greater leverage to the piston and balance-wheel to control the plungers.

Referring to the operation of the elliptic beam, as illustrated in Fig. 4, the four curved dotted lines 1 2 3 4 show the arcs described by the beams, arms, and wrist-pins in making a stroke; No. 1, the arc described by the arm operating the fly-wheel; No. 2, the arc described by the arm operating the descending plunger; No. 3, the arc described by the arm of the ascending plunger; No. 4, the arc described by the arm to which is connected the steam-piston. The two straight dotted lines show the position of the plunger connecting-rods when the right-hand plunger has descended and the left hand risen to end of stroke.

The air-cushion pipe T is made of extra strong lap-welded pipe, and of one to one and a half per cent. of the area and capacity of the pump-barrel. The upper end of the air-cushion pipe is closed air-tight. The lower end is fitted into the receiving valve-chamber S close above the valves. A small air check-valve, *t*, is fitted into the upper end of the pipe T about one-eighth the length below the upper end of the air-cushion, adapted to admit air into but to prevent its escape from the pipe.

Having described the construction of the air-cushion, I will now describe its operation and effect on the action of the engine.

The engine being set in operation, raises the ascending plunger, thus creating a partial vacuum in the pump-barrel R and air-cushion T. When the pressure of the atmosphere outside presses the water into the pump, the plunger, having reached the upper end of the stroke, commences its descent. There is no resistance to the descent of the plunger at the immediate commencement of the stroke until the water has passed into and sufficiently compressed the air in the cushion-pipe T to open the valve leading to the pumping-main, when the descending plunger, continuing its stroke, opens the said discharge-valve and drives the water to its destination. In this action the water is first forced into the air-cushion until the pressure rises about one per cent. higher than it is in the pumping-main. The reason of this slight increase of pressure in the air-cushion is caused by the weights and springs of the discharge-valves resisting the passage of the water into the pumping-main. On the return-stroke, or the ascent of the said plunger, the compressed air in the air-cushion T expands, forcing the water from the cushion-pipe into the receiving-chamber S, under the plunger, thus exerting some seventy per cent. of the power required to reverse the plunger—that is, to start the same on its upward stroke. It is not to be understood that the air-cushion exerts a force of seventy per cent. throughout the whole length of the stroke; but it does exert seventy per cent. of the power required to reverse the plunger and start it on the upstroke; but as the plunger

risers, the force of the air in the air-cushion is reduced by the expansion of the air until the plunger has ascended one and a half inch, when the whole force of the air in the air-cushion is expended, and the cushion ceases to exert any further force to help raise the plunger. On the downstroke the plunger has to descend an inch and a half before the air in the air-cushion is compressed equal to the pressure in the pumping-main. For the first half-inch the resistance is only equal to about ten per cent. of the weight of the plunger, so that ninety per cent. of the gravity of the descending plunger, for the first half-inch of descent, is transmitted by the beam to assist in raising the ascending plunger. As stated above, there is no resistance to the descent of the plunger until water commences to compress the air in the cushion-pipe. The whole weight of the descending plunger, for a short space, is therefore transmitted through the beam to the ascending plunger. The action of the air-cushions on the plungers at the end of the stroke not only exerts a large proportion of the power required to reverse the movement and start the same on the upstroke, but it has also the effect of increasing the elasticity and reducing the jar and strain on the machinery. In proportion as the air-cushion pipe is increased in capacity, the power exerted by the compressed air will be increased, and will act as a motive power for the plunger in its ascent for a proportionately longer time; but as the plunger will have farther to fall before the water commences to compress the air in the cushion-pipe and check the continuously-increasing velocity of the descending plunger, the discharge-valves will open with such suddenness as to result in an increased jarring of the operating mechanism of the pump, and, owing to the rapidity of the descent of the plunger and the suddenness with which the discharge-valves are opened, the air-cushion is incapable of sufficiently checking said movement to prevent the detrimental results of the latter, which, in fact, amount to a concussion similar to what would have taken place if the pump had not been filled.

It will be understood that on the descent of the plunger no water is forced through the discharge-valves into the air-vessel until the air-cushion is first filled; therefore the larger the air-cushion the farther will the plunger have to descend before the air-cushion is filled and the discharge-valves opened. While a large air-cushion would exert a force on the ascending plunger for a greater distance, the objection is that the plunger, having farther to descend before filling a large air-cushion, acquires an increased velocity the farther it falls, and opens the discharge-valves with a suddenness which causes an increased strain on the machinery.

B is the fly-wheel, and C the crank connecting rod with the beam, while the other end of

the beam is connected to the vertical piston-rod cross-head by the short rod or link E. F is the truss supporting the working-beam, and G the guide for the cross-head of the piston-rod. H is the bed-plate of the engine. K is the plunger-guides; M, the exhaust-pipe and heater for the boiler feed-water; N, condenser; O, vacuum-pump; P, channel-way from condenser, and Q injection-pipe of condenser.

10 I claim—

1. The method herein described of operating a pumping-engine, which consists in weighting the pump-plungers in excess of the weight required to discharge a column of water at a given level, and transferring said excess of weight of the descending plunger to the motive-power cylinder, to assist in raising the ascending plunger, substantially as described.

2. The method herein described of operating a pumping-engine, which consists in weighting the pump-plungers in excess of the weight required to raise a column of water to a given level, transferring said excess of weight of the descending plunger to the motive-power cylinder, and storing a supplementary power by the descent of the plunger, which shall assist in raising the same in its turn.

3. In a steam pumping-engine, the combination of two pump-plungers weighted in excess of the weight required to raise the column of water to a predetermined level, means, substantially as described, for transferring the excess of weight of the descending plunger to the motive-power cylinder, to assist in raising the ascending plunger, substantially as described.

4. In a steam pumping-engine, the combination of two pump-plungers weighted in excess of the weight required to raise a column of water to a predetermined level, a motive-power cylinder, and a beam provided with rods attached to the plungers and piston, connected so that the change of leverage of said rods and beam shall transfer the excess of weight of the descending plunger to the motive-power cylinder, to assist in raising the ascending plunger, substantially as described.

5. In a steam pumping-engine, the combination of two pump-plungers weighted in excess of the weight required to raise a column of water to a predetermined level, means, substantially as described, for transferring the excess of weight of the descending plunger to the motive-power cylinder, to assist in raising the ascending plunger, and a chamber in which is

stored, by the descent of the plunger, a supplementary power to assist in raising the plunger in its turn, substantially as shown.

6. The method of operating a steam-engine which consists in loading the engine above the normal load at the beginning of the power-stroke of the piston, when the steam is at its greatest pressure, gradually diminishing said load as the pressure decreases by the expansion of the steam, and finally applying the excess of load to assist the piston in its next power-stroke, substantially as described.

7. In a pumping-engine, the combination of the motive-power cylinder, beam, plungers, weighted as described, and connections between the beam, plungers, and piston, arranged so that the changing leverages in the beam will cause a reduction of the work imposed on the engine in proportion to the reduction of the working-pressure in the cylinder, due to the expansion of the steam after it is cut off, substantially as described.

8. The combination of the two coacting weighted plungers, and an engine for operating the same, with a working-beam of elliptic form, the connections of which are arranged in such manner that the beam-pin of the piston-rod travels an equal distance above and below the center of the beam-shaft, and the beam-pins to which the plunger-rods are connected shall not travel below the center of said beam-shaft, substantially as described, for the purpose specified.

9. The combination of the hollow plungers, and an engine for operating the same, with a working-beam of elliptical form, constructed with four arms differing in length and standing at different angles, the piston, plunger, and crank-connections, and the loading-weights N' of the plungers, substantially as described, for the purpose specified.

10. In combination, in a steam pumping-engine, the loaded plungers J J, the engine L, the elliptic working-beam A, having arms of different length, the working-connections, and an air-cushion, T, connected with the valve-chamber S, all constructed for operation substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

JOSEPH L. LOWRY.

Witnesses:

JAMES H. PORTE,
JOS. H. JACOBS.